EVALUATION OF ERTS DATA FOR CERTAIN OCEANOGRAPHIC USES

Semi-Annual Report #3

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A. WORK SUMMARY DURING THIRD HALF-YEAR PERIOD

1. October 1972 Field Trip

Nearly all data have been worked up that were acquired on our Lake Ontario/Erie field trip. The data collection effort was reported on in detail in our previous semi-annual report.

Efforts were concentrated around the Lake Erie Islands algal bloom that was found most probably to have been the blue-green Aphanizomenon flos-aquae. Thermal scanner data revealed a warmer surface in the bloom area. Although no surface truth appears to exist for this fortuitous find the distribution of the algae is known to correlate with surface currents and convergences from past studies. The extent of the high chlorophyll concentrations is readily apparent in MSS 6 as the surface chlorophyll reflects solar radiation strongly despite a wet surface.

2. Algal Bloom Detection and Mapping

Two other algal blooms were identified:

(a) Utah Lake - 12 Sept. 1972 (reported on earlier)

(b) Lake Erie Islands - 9 Sept. 1972

Although the Utah Lake observation revealed a strong reflection from the algae in both the near-infrared bands (MSS 6 and 7) the radiation observed was somewhat diminished in MSS 7. It has been postulated that the Aphanizomenon-flos aqae bloom in Utah Lake was so thick that the upper surface was dry.

The 9 Sep Lake Erie bloom was better covered by the ERTS-1 swath. An algal streamer was flowing northeastward around Point Pelee and appears to be tracing a pulsing current. Pulsing effects are seen in many Great Lakes river plumes but this observation has not been noticed before in the open lake. It is thought that the pulsing is related to

*Significant Results Identified During Reporting Period (Details in report)

1. Sunglint effects over water can be expected in ERTS images whenever solar elevations exceed 55°.
2. Upwellings were viewed coincidently by ERTS-1 and NOAA-2 in Lake Michigan on two occasions during August 1973.
3. A large oil slick was identified 100 km off the Maryland coast in the Atlantic ocean. Volume of the oil is estimated to be at least 200,000 liters (50,000 gallons).
4. ERTS observations of turbidity patterns in Lake St. Clair provide circulation information that correlates well with physical model studies made 10 years ago.
5. Good correlation has been established between ERTS water color densities and NOAA-2 thermal infrared surface temperature measurements. Initial comparisons have been made in Lake Erie during March 1973.

*(The last four results are new findings during the most recent bimonthly period - Sep/Oct '73.)

a small scale sieche. In the same ERTS-1 scene a wavelike structure is evident off Ashtebula, Ohio in MSS 5 and MSS 6 that parallels the northerly wind. The spacing of these features is several kilometers and could be a result of Langmuir circulations concentrating surface materials (chlorophyll and/or suspended particulate). Since considerable surface truth is available from an Ohio State University research research cruise, we expect more substantiated results will soon be forthcoming.

*3. Sunglint Presents a Problem During Summer

A special notice was submitted on 13 July that alerted ERTS investigators in the "wet world" to sunglint contamination of certain ERTS scenes. Through combined use of imagery from NOAA-2 and ERTS-1 satellites, we have demonstrated that whenever the solar elevation exceeds 55°, the ERTS-1 imagery of water surfaces is subject to considerable contamination (reflectances greater than 0.5%) by sunglint unless the water surface is free of capillary waves. The most pronounced effect occurs in areas of calm water (e.g. to the lee of islands, or under high pressure centers) where "anomalous dark patches" are observed. For more details one should refer to the 13 August 1973 NTIS report (93-73-33). In the Great Lakes these conditions prevail during May, June and July and one needs to be careful in his interpretations when low and variable wind speeds prevail.

*4. Lake Michigan Upwellings

An extensive upwelling episode commenced on Lake Michigan beginning 20 August. Over 3 successive days 5 observations of the evolution of this upwelling were made by the NOAA-2 VHRR. During the middle of these thermal observations ERTS-1 made a pass over the

area. Although the ERTS data have not yet been acquired, surface truth and VHRR data have been coordinated and reveal anomalous biological distributions and circulations. The upwelling lowered surface temperatures over a 24 hour period from 20°C to 10°C and affected a strip along the coast from Point Betsie to Benton Harbor, Mich. The lakeward extent was in excess of 20 kilometers.

An earlier upwelling of similar proportions was witnessed during the ERTS cycle immediately preceding the 21 August observation on 3 August. On this occasion the upwelling processes had been underway several days before the ERTS visit that will allow some interesting comparisons with biological parameters observed.

It is the opinion of the Great Lakes research community that these upwellings were responsible for a marked improvement of water quality this past summer. The importance of regular satellite observations is emphasized as wind observations at land based stations along the Michigan shoreline of Lake Michigan gave no supporting indication of a major upwelling. Winds, although offshore, were less than 10 knots during the entire period. However, ship reports from vessels operating near the upwind shore show that winds as strong as 25 knots were common; sufficient, indeed, for the observed phenomenon.

A paper is being prepared, if accepted, for presentation at the 9th International Remote Sensing of Environment Symposium at Ann Arbor, in April 1974.

*5. ERTS-1 Observes an Oil Slick?

Although not truly a result of the subject NASA contract we are reporting on a recently observed oil spill off the Maryland Atlantic Coast in the Remote Sensing of Environment journal (if accepted). A

minimum 200,000 liters (50,000 gallons) of oil has been identified on the 6 July 1973 ERTS observation in the vicinity of the Washington Submarine Canyon some 100 km southeast of Assategue Island. Although no supporting data have been found that completely substantiate our claim we feel nothing else can explain what is observed other than oil. Sunglint effects prevail as the solar elevation is 61° and capillary waves are obviously damped around the thicker more reflective portion of the oil. In addition, the sunglint reveals several groups of internal waves over the Continental Shelf. The oil slick is in the New York to Cape Hatteras shipping lane and lies nearly directly over the Shelf break.

*6. Circulation Model of Lake St. Clair Confirmed by ERTS-1

Results obtained from a physical model of Lake St. Clair in 1962 by the University of Michigan have been partially confirmed by ERTS. Surface currents in this shallow lake connecting Lakes Huron and Erie were simulated in a model using dye for tracers from the many inflow sources. The major influx of water is through the St. Clair River delta. Outflow is into the Detroit River. As observed by ERTS, the shallowness of the Lake (average depth is about 3 meters) provides considerable turbidity from wind and wave that is easily monitored from space as a natural tracer of circulation. On 28 Sep 72 an excellent view was obtained by ERTS. Prevailing winds had been from the east just prior to the observation. The deeper southern basin was under the influence of a cyclonic gyre as evidenced by the turbidity patterns. This circulation is opposed by a reverse gyre in the extreme eastern end. Patterns to the north, in Anchor Bay, suggest a small anticyclonic gyre. Between this gyre and the southern gyre a southwestward flow

persists that corresponds closely to a straight flow-through situation in the lake. The model, developed for Detroit's Huron-Clinton Metropolitan Authority in 1962, corresponds very closely to these circulations. We are now checking past imagery to see how many wind directions and attendant surface circulations can be matched to the published results of the model.

*7. ERTS-1 Color and NOAA-2 Thermal Data Correlate in Lake Erie

Surface temperatures have been derived for Lake Erie on 27 March 1973 from NOAA-2 VHRR data. Although the temperature range was extremely narrow, from 2°C to 5°C, a good fit was achieved when compared with ERTS imagery of western Lake Erie. This is not a surprising discovery as one would expect the heavy river discharges during spring runoff to be turbid and somewhat warmer that the central lake water. The Maumee and Detroit River plumes are extensive in the imagery as they become entrained in the generalized cyclonic circulation of the Western Basin. During the spring heating season the geostrophic circulation is cyclonic due to the increased temperature of the nearshore areas. Although the temperature-turbidity monitored circulation reveals a high (negative) correlation in the spring, at other times during the year this is not expected to be the case. In the fall the correlation should reverse and may prove to be less distinct, since autumn river discharge is usually considerably less than springtime amounts.

8. Surface Truth Coordination Trip

The week of 22 October was spent obtaining surface truth information at the following locations:

University of Michigan - Ann Arbor, Mich.

University of Wisconsin - Madison, Wisc.

NOAA-Lake Survey - Detroit, Mich.

B. EXPECTED ACCOMPLISHMENTS DURING NEXT REPORTING PERIOD

1. Continue work on circulation atlas of:

   a. S. Lake Michigan

   b. S. Lake Huron and Saginaw Bay

   c. L. St. Clair

   d. L. Erie

   e. L. Ontario

2. Further model comparisons of Lake St. Clair circulations and ERTS inferred currents.

3. Continue to compare NOAA-2 VHRR thermal data with ERTS-1, especially the August Lake Michigan upwelling sequence.

C. PROBLEMS ENCOUNTERED

None.

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